THE REWARDS OF MANAGING WEATHER-RELATED RISKS

WHAT SHOULD I DO WHEN A TORNADO WARNING IS ISSUED FOR MY AREA?
HOW CAN I PROTECT MY PROPERTY FROM A TORNADO?
WHEN SHOULD I EVACUATE FOR A HURRICANE?
SHOULD I DRIVE DOWN THIS FLOODED STREET OR TAKE A 10-MILE DETOUR TO REACH HOME?
WHERE SHOULD I GO ON A GOLF COURSE TO PROTECT MYSELF FROM LIGHTNING?
HOW FAST CAN I SAFELY DRIVE ON WET STREETS OR ON ICE AND SNOW?
WHEN SHOULD I PUT ICE/SNOW MELT SUBSTANCES ON MY SIDEWALK?
WHAT FERTILIZER SHOULD I USE FOR MY LAWN, AND WHEN, TO AVOID POLLUTING STREAMS?

WE ARE ALL RISK MANAGERS.

Risk management! We all do it, and we do it every day. Most of us, though, don't call it that or even think about it that way. When we look both ways before crossing the street, that's an example of *risk avoidance*. Teaching our children to look both ways, to cross at the corner, and to wait for the green light or walk sign at a signal-controlled intersection, is an example of *risk mitigation*. We cannot entirely remove the possibility that a child will run out in front of a car, but we can take steps to reduce the likelihood (or probability) of this tragic event. We also mitigate risk, or lessen the consequences of a potential hazard, when we take an umbrella to work on a sunny morning because our most reliable local weather personality says there is an 80 percent chance of rain for the evening commute. When we buy automobile insurance or flood insurance, that's an example of *risk transference*. If the unlikely, but catastrophic event covered by the insurance policy should befall us, the cost of the consequences is transferred to the insurer (less our deductible, of course). Perhaps, we hear on the radio that the cross-town artery we are planning to take in the next half hour has had a major accident with emergency vehicles on the scene. If we go ahead with our planned drive, betting that the traffic jam will clear by the time we get there or that we can detour by taking an earlier exit, that's just an everyday example of *risk acceptance*. Accepting the risk when we are warned about it, as in ignoring a tornado or hurricane warning, would be a risk acceptance decision, albeit a dangerous one.

Should you bring the umbrella today?

Many of the most important roles we ask of government are related to avoiding, mitigating, transferring, or accepting risks--in short, risk management. Sometimes a Federal, state, or local authority takes on the job managing risks for us, as when firefighters or emergency responders deal with a human-caused or natural disaster. Laws and regulations are made and enforced to limit and guide activities that carry with them inherent risks. Governments at all levels also partner with citizens to manage risks by providing them the information they need to make informed risk-management decisions in their daily lives. That weather forecast about evening storms, government-compiled data on when and why accidents occur, or the government-required warnings and labeling on products, are just a few of the ways we depend on government information to manage the complex risks of life.

Article prepared by Mr. Samuel P. Williamson, Federal Coordinator, OFCM.

FEDERAL ROLES IN CHARACTERIZING AND MANAGING METEOROLOGICAL RISKS.

Whether the ultimate decision on how to manage a risk is made by individuals, a state or local government entity acting on their behalf, or by Federal officials, better decisions are made when the risks involved are well understood. As the kinds of risks, the hazards that cause them, and the extent of their consequences become more complex, the task of *understanding risk* becomes more complex as well. The activities involved in understanding risk (so that good risk-management decisions can be made) go by many names, such as risk identification, risk evaluation, risk assessment, risk estimation, and risk characterization. While the nuances of these terms are important to risk-management experts, for the purpose of this introduction, the most important point is that *understanding the risk is essential to making smart decisions on managing it*, no matter who the decision maker will be.

The Office of the Federal Coordinator for Meteorological Services and Supporting Research (OFCM) is primarily interested in risks that relate to weather or climate in some way. A *hazard* is anything that can cause consequences that present a risk to health and safety or other values, including economic value. The moving vehicle is the hazard you intend to avoid by looking both ways. The rain on your walk home is the hazard whose consequences (wet clothes and a cold) are the risks you reduce (or mitigate) by taking an umbrella to work even on a sunny morning. *Weather-caused hazards* include tornadoes, floods, lightning, blizzards, wind and hail storms, and even hazards from unusual solar activity, called space weather. There are many more kinds of hazards that are not caused by weather but that can be made worse by certain weather conditions. Among these *weather-affected hazards* are air pollution, traffic congestion, accidental or deliberate releases of hazardous materials, and the many potential hazards in moving people or goods around town, around the Nation, or around the world. *Climate-related hazards* include changes in climate patterns and unexpected seasonal variations in weather conditions, such as drought, periods of high wildfire danger, and prolonged periods of unusually severe weather (cold, heat, rain, snow, etc.). The OFCM role in *meteorological risk characterization and management* is to coordinate Federal agency efforts to manage risks from hazards that are weather or climate related.

For anyone who does not work routinely with these risks, the number of Federal agencies that have a role in meteorological risk characterization and management is surprisingly large. In addition to the Federal agencies and programs concerned with helping all of us manage the risks from weather-caused hazards, many more are involved with helping us understand and manage the risks of weather-affected hazards. Here are just a few examples of the most significant Federal activities in meteorological risk characterization and management.

The wide range of mission activities performed by the **Department of Commerce's National Oceanic and Atmospheric Administration** (NOAA) include some of the Nation's most significant-and most familiar-examples of meteorological risk characterization and management. NOAA's National Weather Service (NWS) is the Nation's weather observer and forecaster. NWS products and services, which are distributed in partnership with the commercial media and the private sector, significantly contribute to decisions made by the public, state and local officials, businesses, and Federal managers and help make us all better risk managers. NOAA also has responsibilities for

Hurricane Ivan, September, 2004. NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) operates the weather satellites and its Aircraft Operations Center partners with the Air Force Reserve Command's 53rd Weather Reconnaissance Squadron to fly synoptic surveillance, reconnaissance, and research missions that kept us informed and helped manage this severe weather risk.

characterizing and managing many weather-affected and climate-related risks. Examples include programs that link marine environmental health to human health, advisories about sewage-contaminated water in rivers and near beaches, warnings of hazards to fisheries and their vessels, satellite monitoring of natural and technological hazards, and mitigation response to oil and chemical spills along coasts and in waterways.

The **U.S. Environmental Protection Agency** (EPA) uses information on weather-affected risks in monitoring and managing the quality of the Nation's air and water. For example, the EPA supports research on computer-based modeling of how weather conditions affect airborne pollutants.

It monitors the effects of precipitation, runoff, and flooding on water quality, for both human uses of water and environmental impacts. In September 2004, EPA Administrator Mike Leavitt announced a 32 percent annual decline in sulfur oxide emissions since 1990,and a 37 percent annual decline in nitrogen oxide (NOx) emissions. These pollutants are responsible for acid rain, which is formed when they dissolve in the water of clouds. EPA credits cap-and-trade regulations under its Acid Rain Program for the reductions.

The **U.S. Department of Transportation** (DOT) must deal with both weather-caused and weather-affected risks as part of its responsibilities for the safety and efficiency of the Nation's transportation systems. The DOT's Federal Aviation Administration (FAA) helps the airlines, air transport companies, and general aviation manage the meteorological risks of flying and the indirect impacts of weather on the increasingly crowded National Airspace System. The Federal Highway Administration, Federal Transit Administration, National Highway Traffic Safety Administration, and Federal Railroad Administration do the same for all those who use or manage our surface transportation modes and systems. Other parts of DOT deal with weather- and climate-related risks maritime transportation, pipelines, and the safe transportation anywhere of hazardous materials. Many of these DOT activities illustrate how Federal agencies partner with state and local entities, the private sector, and the academic community to help manage transportation risks with a weather-related component. For example, as an extension of the Strategic Highway Research Program, the Kansas Department of Transportation participated in an anti-icing test and evaluation project that used sodium chloride brine to reduce snow and ice bonding. Results from tests like this help state and local highway departments reduce the risks of winter-driving hazards at lower cost to taxpayers.

The **U.S. Department of Homeland Security** (DHS) shoulders the responsibility for both weather-caused and weather-affected risks as a part of its all-hazards approach to protecting national security at home through preparedness and response. The mission of DHS's Federal Emergency Management Agency (FEMA) is to reduce loss of life and property and protect the Nation's critical infrastructure from all types of hazards through a comprehensive, risk-based program of mitigation, preparedness, response, and recovery. These hazards range from severe weather events like hurricanes, floods, and tornadoes to accidental and intentional releases of airborne chemical, biological, radiological, or nuclear materials.

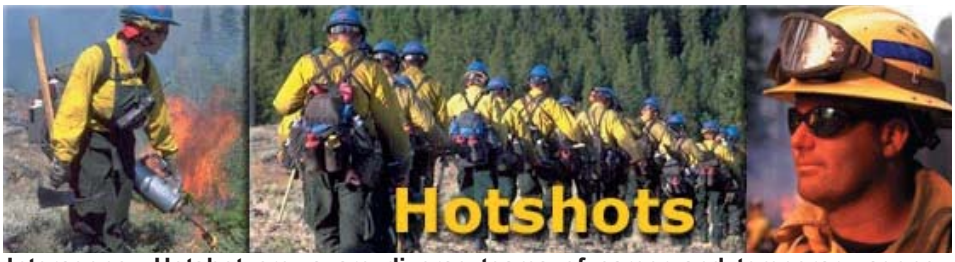
These shuttered windows in Southport, North Carolina, are an example of protective measures that individuals can take against hurricane-force winds before they arrive. The hinges are permanently mounted for easy on/off installation in response to warnings of approaching storms.
FEMA News Photo - Dave Saville.

The **U.S. Department of Energy** (DOE) also has responsibility for weather-affected transportation risks. DOE is responsible for ensuring that shipments of radioactive material are conducted safely. DOE's National Transportation Program relies on tailored weather information for route planning to mitigate risks from weather-affected accidents during transit.

The **U.S. Department of Defense** (DOD) through the U.S. Army Corps of Engineers (USACE), is a major partner in risk mitigation for flooding hazards along the Nation's major rivers. Many DOD operations at home and abroad depend on weather information to mitigate weather-affected risks to operational effectiveness. In response to the damage wrought by Hurricane Ivan in West Virginia, project officers and quality control engineers from the USACE teamed with FEMA's Public Assistance staff and the National Guard to aid in debris removal and other Hurricane Ivan recovery projects in 16 of the state's hardest-hit counties.

The **National Aeronautics and Space Administration** (NASA) frequently partners with other Federal agencies on the research and development (R&D) needed to improve risk characterization and management. NASA works with NOAA to design, develop, and test new weather-observing satellites and remote sensing instruments. NASA and the FAA work together on developing and implementing the tools and systems used by air traffic controllers, pilots, airlines, and general aviation pilots to lessen the risks of both weather-caused and weather-affected aviation risks.

NASA's Synthetic Vision System (SVS) cockpit display will offer pilots a clear, three-dimensional picture of the terrain outside the aircraft even in the worst weather or darkest night conditions.



Interagency Hotshot crews are diverse teams of career and temporary agency employees who have solid reputations as multi-skilled professional firefighters. These crews are employed by the Forest Service, the Bureau of Land Management, the National Park Service, various Native American tribes, and the states of Alaska and Utah.

The **U.S. Department of Agriculture** (USDA) addresses climate and weather risks in agricultural conservation, crop spraying, and wetland management. Its U.S. Forest Service handles weather-affected risks, such as suppressing wildland fires and conducting prescribed burns to reduce the risk of wildfires. The Agricultural Research Service helps farmers and others with watershed flood control and participates in climate-change research projects.

RECENT CONSENSUS RECOMMENDATIONS ON METEOROLOGICAL RISK MANAGEMENT.

In February 2001, the OFCM and the National Science and Technology Council, Committee on Environment and Natural Resources, Subcommittee on Natural Disaster Reduction jointly sponsored a Forum on Risk Management and Assessments of Natural Hazards. The forum included representatives from Federal agencies, academia, and industry. The theme of the forum was: *Toward a Safer America: Building Natural Hazard Resistant Communities through Risk Management and Assessments*. Overarching issues and challenges posed to the participants included examining risk assessment processes and ways to build a consensus to proceed with a national natural hazard assessment. A forum goal was to facilitate risk assessment and management of natural hazards through legislative proposals, policy guidance, and agency cooperation.

The participants in this forum concluded that the best approach to a national assessment of natural hazards was to conduct it in bite-size chunks-a series of smaller, focused assessments. For example, a thorough assessment could be conducted focused purely on hurricanes. The needed talents and resources of the Federal agencies could be coordinated and dedicated to completing such an assessment nationwide, at which time the assessment for another major natural hazard could be organized and begun. A vital part of these assessments would be to determine and understand stakeholder risk tolerances, with the intent of assisting managers at all levels in making better-informed decisions on managing risks from these hazards. The list of natural hazards to be assessed included tornadoes, hurricanes, volcanoes, earthquakes, and tsunamis.

At this forum and other meetings at the national level, stakeholders and agency representatives have concluded that the United States needs an adequate national warning system to alert those at risk to imminent natural and human-made hazards. To make warnings more effective, research is needed on risk communication and risk perception. Understanding how people perceive risk and interpret warnings about potential hazards will help make

warning systems more effective. How individuals perceive risks involves factors such as their beliefs about their personal safety and whether they are likely to suffer economic losses. Other key factors include the credibility of the person or authority issuing a warning and the familiarity with the hazard and its potential consequences.

Risk characterization and management offer a method of identifying risks; evaluating them on the basis of their likelihood, severity, and consequences; and allocating resources to control them on the basis of their importance. This can enable decision makers to identify and evaluate effective and efficient risk mitigation options, then choose among those options that minimize risk at reasonable levels of practicality and affordability. After implementing the selected options, those responsible for risk management can monitor system performance to determine whether risk control measures are effective. This iterative process of assessment, management decision, implementation, and evaluation can, over time, continue to reduce risks. Agency and public responses to Hurricanes Charley, Frances, Ivan, and Jeanne in 2004, provide abundant examples of the importance of risk analysis and assessment in decisions to evacuate and in actions to protect property. The press reported many personal stories of people who, in hindsight, would have made different decisions if faced with similar hazards in the future.

The success of risk assessments for most hazards rests on identifying a potential hazard or dangerous situation and describing the mechanisms by which the hazard can cause harm to people, property, and the environment. The next step is to define the probabilities of the component parts. Typically, this means estimating the probabilities of the initiating events, such as weather and climate. The risks are then analyzed for each hazard or for a set of hazard scenarios. The severity of the consequences can be expressed in human terms, such as fatalities, injuries or some other metric like dollars lost. The likelihood of concurrence of an adverse event can be estimated by a variety of methods, ranging from prior experience with the frequency of occurrence to computations based on mathematical models.

In October 2003, several massive wildfires raged across southern California. Wildfires that month in California, fanned by dry Santa Ana winds from the mountains, killed at least 15 people and burned more than 500 homes. Drought conditions across the region, after years of wildland brush and tree growth, had created ample quantities of fuel ready to be sparked by lightning or a careless human. Fire danger alerts when dry winds are forecast and prescribed burns are among the tools used to manage the wildfire risk.

Momentum has been building in recent years to focus more attention and resources on disaster mitigation and planning. Initiatives are underway or planned to include measures such as:

- Anticipation and assessment of risk, not simply reaction to disasters;
- Focusing on mitigation activities that build resilience at the earliest planning stages, not as an afterthought, and dealing with mitigation comprehensively rather than piecemeal; and
- Development and implementation of warning and dissemination systems that allow society to bring its resilience into play.

The intent is to expand disaster preparedness activities beyond saving lives. Added benefits will help to ensure the continued, uninterrupted functionality and viability of communities, regions, and their associated managed and natural ecosystems to help create a sustainable society, resilient to natural and other disasters.

Research is needed to assist with these initiatives, especially with respect to:

- The physical and biological structure and character of the hazards themselves;
- Improved risk assessments to guide natural disaster reduction;
- Holistic, systems-level understanding of the socioeconomic factors driving societal vulnerability and the full range of engineering and other strategies available to improve mitigation and adaptation; and
- Improved use of new information technologies to disseminate warnings and provide integrated, ready access to information on natural disaster reduction.

This research will improve the links between the physical, biological, and social sciences; economics; and environmental policy. It will also aid in developing science policy tools to guide research, development, and operational implementation decisions.

NEXT STEPS IN COORDINATING FEDERAL EFFORTS AND FOSTERING PARTNERSHIPS.

The coordinated efforts of the Federal agencies to address the spectrum of risks from hazards caused by or affected by weather and climate will require a minimum of three steps.

- The first step is to gather more comprehensive risk data on the hazard. The data should include economic costs associated with the risk, as well as quantitative assessments of the risks to human health and safety. The cost and benefits of potential mitigation

options should also be considered.

• The second step is to incorporate the comprehensive risk information into the decision-making process at all levels-public and private. Providing clear and accurate information about the nature of risks can help people make realistic assessments of the risks they face and, where appropriate, to make informed judgements on how to handle risks themselves. Education and outreach will help people understand hazard risks and apply the information in a more effective manner.

• Experience with risk processes in decision making will allow further identification of deficiencies in the hazard risk information or its application and communication. Research may be needed to resolve these deficiencies. The third step will be to coordinate among the Federal agencies on priorities and plans to conduct related research and to help bring improved science and/or technology into practice. The resulting improvements in risk characterization and management will save lives and better protect the natural and economic resources of our citizens and communities.